

## **REMARKS/ARGUMENTS**

### **Status of the Claims**

Claims 1-30 and 36-40 are rejected.

Claims 1, 2, 4, 16-20, 29 are currently amended.

New claims 41-49 have been added.

Claims 31-35 are withdrawn.

Claims 1-30 and 36-49 are pending.

### **Objection to the Oath/Declaration**

In the Office Action of June 26, 2003 the Declaration of the inventors was objected to as being defective, and a new oath or declaration is required. In reply, a new *Declaration for Utility or Design Application using an Application Data Sheet*, executed by the inventors, is enclosed with the Application Data Sheet. Applicants believe that this *Declaration* is in full compliance with the requirements of 37 CFR 1.67(a).

### **Objection to the Specification**

The specification is objected to in the Office Action of June 26, 2003 as being in need of updated, complete and accurate serial numbers, noting pages 18, 19, 26, 30 and 31 and paragraph nos. 0048 and 0073 in particular. In response, Applicants have amended the relevant paragraphs of the Specification to correct and/or update the serial numbers. No new matter is introduced by way of these amendments.

### **Objection to the Claims**

Claim 4 is objected to in the Office Action as containing a grammatical error. In response, Applicants have amended claim 4 to improve grammar and claim form. The phrase "a millisecond contact time reactor having a gas mixing zone, a reaction zone capable of withstanding temperatures up to at least 1,500°C, and a cooling zone" has been removed from between "comprises" and "mixing." Instead, claim 4 now recites providing "a millisecond contact time reactor having ... ."

### **Rejection of Claims Under 35 U.S.C. § 112, Second Paragraph**

Claims 2 and 4 stand rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicants regard as their invention. It is said in the Office Action that claims 2 and 4 do not distinctly set forth what the "desired gaseous product" is. It is said that the metes and bounds of "desired gaseous product" have not been provided in claims 2 and 4. In reply, Applicants have currently amended claim 2 to recite that the

H<sub>2</sub>S-containing gas stream also comprises a gaseous component other than H<sub>2</sub>S, and that the process includes recovering that other component from the product stream. Claim 4 has been amended similarly, and now provides that the H<sub>2</sub>S-containing gas stream may include a gaseous component other than H<sub>2</sub>S; the product stream may contain that gaseous component; and the process may include recovering the same gaseous component.

#### **Voluntary Amendments**

Applicants have amended claim 1 to make it clearer that cooling the product stream to the dewpoint temperature of elemental sulfur, or lower, allows sulfur to condense, and that condensed elemental sulfur is recovered from the cooling zone. Claim 1 has also been amended to make it clearer that the reactant gas mixture is maintained at a temperature above the dew point of elemental sulfur. Claims 16 - 20 have been amended to make it clearer that it is catalytic metal(s) which possess(es) the stated property or which constitute a Markush group. Claim 29 has been amended to make it clearer that it the catalyst device includes one or more catalytic carbided metal.

New claims 41 - 46 have been added to better ensure coverage of specific embodiments to which Applicants are entitled. Claims 41-43 require that the H<sub>2</sub>S-containing gas stream contains 0.5 - 100 % H<sub>2</sub>S, or a subrange thereof. New claims 44-46 require H<sub>2</sub> or hydrocarbon in the H<sub>2</sub>S-containing gas. New claim 47 requires a catalyst that is more selective for partially oxidizing H<sub>2</sub>S than for partially oxidizing hydrocarbon. New claim 48 is drawn to a specific embodiment reciting certain preferred contact times and contacting temperature. New claim 49 requires passing the reactant gas mixture over the catalyst at a space velocity of at least about 100,000 h<sup>-1</sup>.

#### **Rejection of Claims Under 35 U.S.C. § 103(a)**

In the Office Action of June 26, 2003 claims 1-20, 23, 29, 30 and 36-40 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Pat. 5,654,491 ("the '491 patent") in view of pg. 1 paragraph [0003] of Applicants' specification and WO 97/19019. It is said that it would have been obvious to one of ordinary skill in the art at the time Applicants' invention was made to further describe the process of the '491 patent as promoting the oxidation of the hydrogen sulfide that is inherently present in the natural gas feedstock that the process that the '491 patent treats (as evidenced by paragraph [0003] of Applicants' specification, in the manner required by Applicants' claims. It is further suggested in the Office Action that the disclosure set forth on pg. 21, line 11 of WO 97/19019 is

evidence that the Pt and Rh of the '491 patent will inherently promote the oxidation of the hydrogen sulfide that is inherently present in the natural gas feedstock that the process of the '491 patent treats.

**H<sub>2</sub>S is not Inherent in the Feed Gas Mixture of the '491 Patent**

The MPEP §2112 states that, if inherency is asserted, the Examiner must provide rationale or evidence tending to show inherency. More specifically,

[i]n relying upon the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art. *Ex parte Levy*, 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990).

and

[t]he fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish inherency of that result or characteristic. *In re Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993) (reversed rejection because inherency was based on what would result due to optimization of conditions, not what was necessarily present in the prior art)

Applicants respectfully traverse the Office Action's proposition that hydrogen sulfide is inherently present in the natural gas feedstock that the process of the '491 patent treats. While it is well known in the art (and discussed by Applicants at paragraph [0003] of the Specification) that natural gas may contain hydrogen sulfide, it is also well known and documented in the literature that hydrogen sulfide, and other incidental sulfur-containing compounds, are customarily removed from a natural gas feedstock before it is introduced into other industrial process, e.g., syngas production. For example,

*U.S. Patent No. 6,497,812* states at col. 6, ll. 49-55,

Regardless of the system used to produce syngas it is desirable to remove any sulfur compounds, e.g., hydrogen sulfide and mercaptans, contained in the C<sub>1</sub>-C<sub>3</sub> alkane feed. This can be effected by passing the C<sub>1</sub>-C<sub>3</sub> alkanes gas through a packed bed sulfur scrubber containing zinc oxide bed or another slightly basic packing material.

*U.S. Patent No. 5,985,178* states at col. 4, ll. 39-45,

Whatever the source of hydrocarbon for the FBSG [fluid bed syngas generator] feed, it is also important to remove sulfur compounds from the hydrocarbon by any of many known means before it is passed into the FBSG, as is known to those skilled in the art, to prevent either catalyst deactivation or loss of catalytic activity, depending on the catalytic metal components.

*U.S. Patent No. 5,720,901* states at col. 5, ll. 11-31,

If natural gas or associated gas are being employed, sulfur-containing compounds may be present in the gas as it is produced from the reservoir. Such sulfur-containing hydrocarbon feedstocks may conveniently be used as a feed to the process of the present invention without first undergoing a desulfurization treatment, such as is conventionally applied.

The sulfur-containing compound should be present in the feed mixture in a sufficient concentration to reduce the formation of ammonia and hydrogen cyanide. However, the quantity of the sulfur-containing compound should not be so great as to significantly reduce either the activity or the selectivity of the catalyst being employed. Thus, the sulfur-containing compound is preferably present in the feed mixture in an amount to give a sulfur (S) content in the range of from 0.05 to 100 ppm, more preferably from 0.1 to 50 ppm, especially from 0.1 to 10 ppm. Hydrocarbon feedstocks used directly from naturally occurring reservoirs in which the sulfur content is significantly above the aforementioned upper limits may preferably be subjected to a partial sulfur removal treatment before being employed in the process of this invention.

In Applicants' Specification at paragraphs [0008] and [0009], and in *U.S. Patent No. 6,579,510* at col. 2, lines 29-40, it is stated,

Further complicating the exploitation of the world's natural gas supply is the fact that many natural gas formations contain H<sub>2</sub>S in concentrations ranging from trace amounts up to about 3-25% (by volume) hydrogen sulfide. For example, many of the catalysts that are conventionally used for the production of synthesis gas are poisoned by the presence of sulfur.

If the hydrocarbon conversion does proceed to some degree, the syngas product is typically contaminated by passed through H<sub>2</sub>S and/or SO<sub>2</sub>. The presence of H<sub>2</sub>S or SO<sub>2</sub> generally diminishes the usefulness of the syngas or creates environmental safety concerns.

The customary practice of advance removal of sulfur content is also described in *U.S. Patent No. 6,221,280* (the '280 patent), which states at col. 2, ll. 33-38,

In addition to carbon formation, the processes for liquid hydrocarbon fuel conversion to hydrogen/carbon monoxide gas streams may be affected by the sulfur that is usually present in these fuels. In both light and heavy hydrocarbon fuels, but particularly the latter, sulfur is present in varying amounts.

and at col. 2, ll. 50-60,

As with carbon formation, sulfur can poison the catalyst and do so to a point where the catalyst becomes completely deactivated. Catalysts based upon nickel or platinum have appeared to be particularly susceptible to poisoning. It has been postulated that sulfur forms surface stable compounds with the catalyst. Thereby, catalyst active sites for oxidation are depleted and efficient production of hydrogen and carbon monoxide through catalytic partial oxidation is hindered.

One potential solution to the presence of sulfur has been to remove the sulfur prior to processing.

At col. 2, l. 60 - col. 3, l. 13, the '280 patent teaches that, depending on the H<sub>2</sub>S concentration, two treatment methods are used in advance of catalytic partial oxidation of a hydrocarbon: (a) for low concentrations of sulfur compounds (*i.e.*, less than a few percentage), gas-solid adsorption methods work satisfactorily, with intermittent sorbent regeneration; and (b) for higher concentrations of sulfur compounds, amine gas-amine absorption methods work better. It is noted, however, that the latter also requires regeneration and is expensive.

At col. 3, ll. 13-17, the '280 patent states,

A solution around the problem in partial oxidation has been to omit the catalyst entirely (*i.e.*, non-catalytic partial oxidation), particularly for converting heavy hydrocarbons on an industrial scale, and removing the sulfur, if necessary, after the partial oxidation reactor.

In the case of heavy hydrocarbon feeds, it is said, at col. 11, ll. 47-52,

The product gas **20** substantially comprises hydrogen gas, carbon monoxide, carbon dioxide, water vapor, hydrogen sulfide, methane, traces of unconverted hydrocarbons, traces of other sulfur compounds, and nitrogen, if the oxidizer gas is air or oxygen-enriched air.

One can readily appreciate that it would have been contrary to customary and accepted practice in the industry at the time the present invention was made to deliberately feed significant amounts of hydrogen sulfide into a syngas production process. This is especially clear in light of the expected drawbacks, including catalyst deactivation, formation of undesirable sulfur and carbon-containing products, loss of H<sub>2</sub> yield, and decrease in efficiency of O<sub>2</sub> use, which are typically attributed to the presence of sulfur in hydrocarbon partial oxidation processes.

It is noteworthy that the '491 patent does not teach using natural gas as its feed gas stream, and it is completely silent as to hydrogen sulfide. For example, at col. 4, lines 3-5, the '491 patent states,

The present invention is directed to a process for the partial oxidation of hydrocarbons (preferably, normal (C<sub>2</sub>-C<sub>4</sub>) alkanes, and more preferably, normal butane) to form relatively high concentrations of oxygenates and relatively low concentrations of CO and CO<sub>2</sub>.

and at col. 5, lines 36-45, the '491 patent states,

The feed gas stream (*i.e.*, feed gas mixture) consists of an oxygen-containing gas (preferably, O<sub>2</sub>) and a hydrocarbon gas. Preferably the hydrocarbon gas includes one or more normal (C<sub>2</sub>-C<sub>4</sub>) alkanes (more preferably, normal butane). Although the hydrocarbon gas can include a minor amount of methane (*i.e.*, no more than about 50 mole-%, preferably, no more than about 15 mole-%), it is particularly desirable if the hydrocarbon gas (and therefore, the feed gas mixture) is substantially methane free. [underlining added for emphasis]

Since it is well known that the major component of natural gas is methane, and a) the Examples in the '491 patent use only butane or a mixture of ethane and propane as the hydrocarbon, and b) it is expressly stated that the mixture is preferably free of methane, and c) the partial oxidation process of the '491 patent "produces a relatively small amount of CO and CO<sub>2</sub>," (col. 6, ll. 34-35), then one of ordinary skill in the art at the time Applicants' invention was made would be more likely to conclude that the feed gas stream of the '491 patent does not contain natural gas than to conclude that H<sub>2</sub>S is inherently present in the reactant gas mixture.

Therefore, there is insufficient factual basis to support the Office Action's proposition that hydrogen sulfide is necessarily and inevitably present in the hydrocarbon-containing reactant gas mixture that the process of the '491 patent treats. As discussed above, a contrary conclusion could be reasonably made from the teachings of the '491 patent by one of ordinary skill in the art at the time Applicants' invention was made.

**Elemental Sulfur Not Produced/Condensed in the Process of the '491 Patent**

In the Office Action of May 26, 2003 it is acknowledged that the process of the '491 patent does not include passing the resulting elemental-sulfur containing gas through a cooler at a temperature that is lower than the dew point of sulfur, as in Applicants' claims. However, it is suggested that this difference would have been obvious to one of ordinary skill in the art at the time Applicants' invention was made because of the necessity of condensing and removing the elemental sulfur out of the gas that would have otherwise escaped out and into either the atmosphere or other downstream processing equipment.

Applicants respectfully traverse that assertion for at least the same reasons as discussed above. No sufficient basis in fact or technical reasoning has been provided in the Office Action which would tend to support a determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art. The fact that raw natural gas may contain C<sub>2</sub>-C<sub>4</sub> hydrocarbons in addition to methane, and that it may also may contain sulfur compounds (including H<sub>2</sub>S) merely supports the customary and usual practice in the art of depleting the natural gas of its sulfur-containing components prior to its use in a partial oxidation process (as discussed above and documented in the literature). Absent the certainty that a sufficient amount of H<sub>2</sub>S would necessarily be present in the reaction gas mixture to necessarily produce a condensable amount elemental sulfur in the product gas stream of the '491 patent, it cannot be assumed that a sulfur condenser would be an obvious addition to

the apparatus of the '491 patent or that recovering elemental sulfur would be obvious. One of ordinary skill in the art would not be motivated to increase the size and cost of a partial oxidation plant without a compelling reason to do so.

Moreover, there is clearly no teaching or suggestion in the '491 patent of maintaining a 2:1 ratio of  $H_2S$  to  $O_2$  in the reactant gas mixture (claim 5). There is no teaching or suggestion of recovering an at least partially desulfurized light hydrocarbon stream (claim 7). Likewise, there is no teaching or suggestion of  $H_2$  in an  $H_2S$ -containing gas stream, nor of recovering an at least partially desulfurized hydrogen stream (claim 8).

**WO 97/19019 is Not Combinable with the '491 Patent**

In the Office Action of May 26, 2003, *PCT Published Application WO 97/19019* (in the French language) is cited against claims 1-20, 23, 29, 30 and 36-40. *U.S. Patent No. 6,083,471* states that it is the U.S. national stage counterpart of *WO 97/19019*. Therefore, Applicants' respectfully request leave of the Examiner to refer to passages in the English language counterpart ("the '471 application") in addition to or instead of the corresponding cited passages of *WO 97/19019*, which are in the French language.

In the Office Action it is said that *WO 97/19019* discloses a process for the oxidation of hydrogen sulfide into elemental sulfur by passing the hydrogen sulfide-contaminated gas through a catalyst containing a variety of catalytic metals wherein the catalytic metals are supported on a silicon carbide support. It is said that the advantages of using a silicon carbide support are reported in *WO 97/19019* to be the resistance to sulfation and the avoidance of combustion. The Office Action also states that pg. 2, ll. 8-30 and pg. 4, ll. 13-18 of *WO 97/19019* give examples of the catalytic metals that may be used to promote the oxidation of the hydrogen sulfide into elemental sulfur (to include Pt and Rh, which is said to be expressly mentioned at col. 9, l. 31 of the '491 patent). The cited passages of *WO 97/19019* are believed to correspond, respectively, to the passages of *U.S. 6,083,471* at col. 1, ll. 41-64,

...one or more compounds of transition metals chosen from Fe, Cu, Zn, Cd, Cr, Mo, W, Co and Ni, preferably Fe, and optionally with one or more compounds of precious metals chosen from Pd, Pt, Ir and Rh, preferably Pd (FR-A-2511663), or else of a thermally stabilized alumina used in combination with one or more compounds of transition metals such as the abovementioned, especially Fe, and optionally with one or more compounds of precious metals chosen from Pd, Pt, Ir and Rh (FR-A-2540092).

Oxidation of  $H_2S$  to sulphur, the operation being carried out at temperatures such that the sulphur formed is deposited on the catalyst, can, for its part, be performed in contact with a catalyst consisting, for example, of one or more compounds such as salts, oxides or sulphides of transition metals, for example Fe, Cu, Cr, Mo, W, V, Co, Ni, Ag and Mn, in combination with a support of the activated alumina, bauxite, silica/alumina or zeolite type (FR-A-2277877). This oxidation of  $H_2S$  with deposition of sulphur on the catalyst can also be carried out in contact with a catalyst consisting of a catalytic phase chosen from the oxides, salts or sulphides of the metals V, Mo, W, Ni and Co used in combination with an active charcoal support (French Patent Application No. 9302996 of 16.03.1993).

and at col. 2, ll. 51-63,

In particular, the active phase used in combination with the silicon carbide support in order to form the oxidation catalyst according to the invention is advantageously composed of at least one transition metal, such as nickel, cobalt, iron, copper, silver, manganese, molybdenum, chromium, titanium, tungsten and vanadium, the said metal being in the oxide, sulphide or salt form and/or in the elemental state. The said active phase, expressed as weight of metal, most often represents 0.1 to 20%, more particularly 0.2 to 15% and more especially 0.2 to 7% of the weight of the oxidation catalyst. The silicon carbide support advantageously forms at least 40% and more particularly at least 50% of the weight of the oxidation catalyst.

Applicants respectfully traverse this rejection for at least the reason that it is apparent there is no teaching in the '471 patent (and by extension, the *WO 97/19019* patent) of the specific catalyst compositions of claims 21, 22, or 25-30. In currently amended claims 29 and 30 it is made clearer that it is the catalytic metal which is carbided, in contrast to the carbided support taught in the '471 patent (also *WO 97/19019*).

Moreover, there is no motivation in the prior art to combine the teachings of the '471 patent with those of the '491 patent. The process of the '491 patent does not purport to partially oxidize  $H_2S$  nor does it purport to produce elemental sulfur. Factual basis is lacking for assuming that  $H_2S$  is inherently present in the reaction gas mixture of the '491 patent. The MPEP at § 2143.01 requires that there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify or combine the reference teachings. In the instant matter, the nature of the problem to be solved is different in the cited references and one of ordinary skill in the art would not be motivated to modify the process of the '491 patent with a catalyst that is used in a markedly different process. For example, the '471 patent teaches that a catalyst contact time in the range of 0.5 - 20 seconds is required (col. 3, ll. 55-57). By contrast, the process of the '491 patent requires a much shorter contact time (*i.e.*, less than .5 seconds, preferably less than .2 seconds) (col. 7, ll. 45-47).



**The '819 Patent is Not Combinable with the '491 Patent**

In the Office Action of June 26, 2003, it is said with respect to claims 1-30 and 36-40 that the difference between the Applicants' claims and the '491 patent is that Applicants' claims 21, 22 and 24 through 28 call for the presence of a lanthanide-based metal such as La or Sm as the catalyst that promotes the oxidation of the hydrogen sulfide into elemental sulfur. The Office Action takes the position that *U.S. Patent No. 6,099,819* ("the '819 patent") discloses a similar process for the catalytic oxidation of hydrogen sulfide into elemental sulfur by passing the H<sub>2</sub>S-contaminated gas through a catalyst that may be selected from a variety of rare earth metals to include the La and Sm of claims 1-30 and 36-40.

In reply, Applicants respectfully traverse for at least the reason that the process of the process of the '819 patent is in a markedly different area of technology than the '491 patent, and is not a "similar process." The '491 patent "is directed to a process for the partial oxidation of hydrocarbons ... to form relatively high concentrations of oxygenates and relatively low concentrations of CO and CO<sub>2</sub>." (col. 4, ll. 3-7). The process is carried out at short contact times and high flow rate. By contrast, the '819 patent is directed to catalysts and a process for the oxidation of hydrogen sulfide to elemental sulfur and water. Those catalysts are said to operate "at temperatures between about 100°C. and about 400° C. ..." (col. 5, ll. 35-37) and function "in the presence of potentially interfering substances, such as carbon dioxide, water, and hydrocarbons ..." (col. 5, ll. 27-28)

The MPEP states at § 2143.01 that there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify or combine reference teachings. In the instant matter, the nature of the problem to be solved in each of the cited references is different and there is no suggestion or motivation in the art to modify the process of the '491 patent as proposed in the Office Action. The '819 patent teaches away from such a combination.

For example, the '819 patent states, at col. 13, ll. 4-8,

Introduction of up to 14% of hydrocarbon, e.g., methane, in the feed had no significant effect on H<sub>2</sub>S conversion and S selectivity of the coprecipitated 7.5%Nb/TiO<sub>2</sub> catalyst. Further, no new by-products of reaction were observed on addition of methane to the feed. Introduction of up to 0.3% toluene in the feed to the reactor did not result in the deactivation of the catalyst.

Clearly, using a catalyst that is non-catalytic with respect to hydrocarbon components of the reaction gas mixture would defeat the purpose of the process of the '491 patent if the two references were

combined as suggested in the Office Action. See the MPEP at § 2143.01 (proposed modification cannot render the prior art unsatisfactory for its intended purpose or change the principle of operation of a reference).

**Proceeding Contrary to Accepted Wisdom is Evidence of Non-Obviousness**

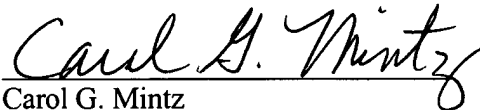
In light of the conventional thinking in the industry with respect to pretreating hydrocarbon streams such as natural gas to remove H<sub>2</sub>S before introducing such streams into other processes (*e.g.*, synthesis gas production), Applicants submit that one of ordinary skill in the art at the time Applicants' invention was made would consider it contrary to customary and usual practice to proceed as taught in Applicants' claims 1-30 and 36-40. The MPEP at § 2145 (D)(3) notes that a departure from accepted wisdom is evidence of non-obviousness.

**Conclusion**

Applicants respectfully request reconsideration of this application in light of the foregoing amendments and remarks. In the preceding Remarks/Arguments, Applicants may have at times referred to claim limitations in shorthand fashion, or may have focused on a particular claim element. This discussion should not be interpreted to mean that the other limitations can be ignored or dismissed. The claims must be viewed as a whole, and each limitation of the claims must be considered when determining the patentability of the claims. Moreover, it should be understood that there may be other arguments with respect to patentability which have yet to be raised, but which may be raised in the future. This is believed to be a full complete response to each and every ground of rejection and objection raised in the Office Action of June 26, 2003. If Applicants have incompletely addressed any item, an opportunity to supplement this Response is respectfully requested. The format of this Amendment and Response to Office Action is believed to conform with the Revised Amendment Practice as described in "Changes To Implement Electronic Maintenance of Official Patent Application Records," 68 Fed. Reg. 38611 (June 30, 2003).

If a telephone conference would be helpful in advancing prosecution of this case, the Examiner is invited to telephone the undersigned representative. Should any fees have been inadvertently omitted, or if any additional fees are required or have been overpaid, please appropriately charge or credit those fees to Deposit Account Number 03-2769 of Conley Rose, P.C., Houston, Texas, and consider this a petition for any necessary extension of time.

Respectfully submitted,



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